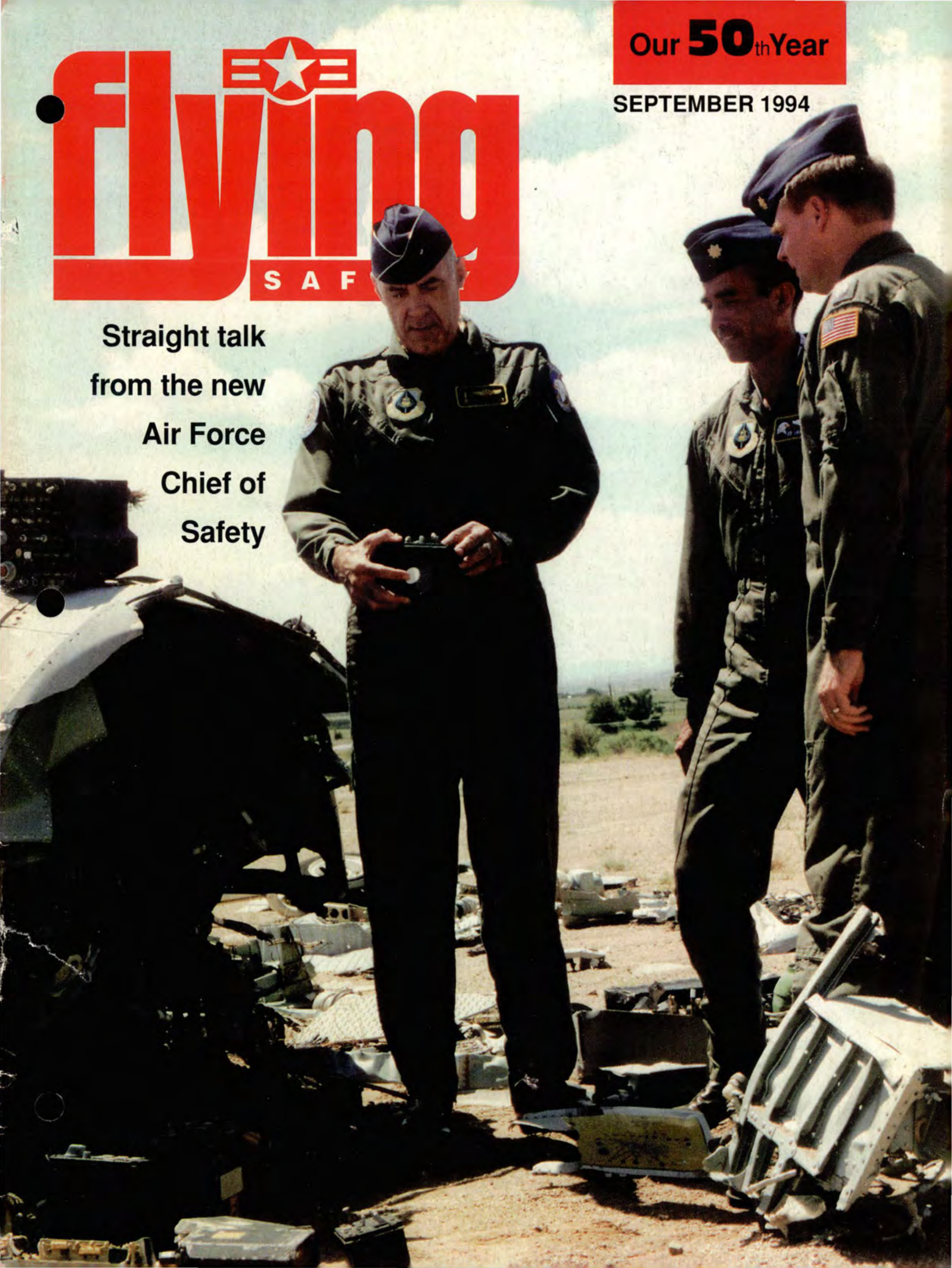
Flying Safety

Our 50th Year

SEPTEMBER 1994

Straight talk from the new Air Force Chief of Safety



Straight talk from the new Air Force Chief of Safety

There Is No Magic Bullet

BRIGADIER GENERAL
Orin L. Godsey
USAF Chief of Safety

"... While quality initiatives in the Air Force appropriately emphasize process improvement rather than blaming people, there is a point where individual accountability is entirely appropriate. ***Safety is an individual responsibility.***"

■ Iraq. Pope. Fairchild. These are the names of places where we've recently suffered some of our most tragic mishaps. Mishaps which took the lives of good people and measurably reduced our war-fighting capability. They were not acts of God. They were failures in leadership, discipline, and individual integrity.

The challenges Air Force people face today are numerous and complex. As the world's most respected air and space force grows smaller, the operations tempo we each experience is increasing. To quote Secretary Widnall and Air Force Chief of Staff General McPeak in a recent press release, "We are, in some respects, victims of our own success. We are asked to take on difficult missions because we have done them successfully in the past. Our national leaders recognize and value the unique qualities the Air Force brings to the fight — global reach, global power, and increasingly, global presence."

Safety isn't paramount. But mission accomplishment is not always paramount either. Each new mission requires looking at the required outcome and accepting an appropriate level of risk to achieve that outcome.

Lower manpower and budget levels are going to continue for the near future. As such, each new mishap we experience is even more painful. It further reduces our ability to put fire and steel on a target — or deliver food and medicine to the sick and hungry.

Our people are operating in a sea of instability. They are still adjusting to their new roles and responsibilities. Familiar faces we once relied on are no longer there. Competition for promotion is becoming even more keen. We've known for years change is a catalyst for accidents.

Our off-duty mishap rates also critically impact our mission resources. Lower force levels, less time for training, rapid changes in missions, and career requirements are factors which impact mishap prevention — factors which cause our people to lose focus as they drive through the front gate.

The pressures we face as a smaller force have also impacted our safety reporting system. Increasingly, material or system failures are identified as causal for mishaps in safety reports. Yet, other factors which contribute to mishaps, such as individual breaches of checklist discipline or adherence to technical orders, are not being identified. People make mistakes. Quality initiatives help reduce, but will not always eliminate human error. We must reflect that reality; we cannot afford to be a one-mistake air force.

In some cases, we haven't taken time to identify the risks associated with the mission. We've relied on our experience to get us through. We sometimes fell into the "been there, done that syndrome" and were blind to the unique demands of a new mission. The paradigms on which we based our decisions did not represent the new environment. As leaders we've sometimes failed to clearly define the new rules of engagement.

While quality initiatives in the Air Force appropriately emphasize process improvement rather than blaming people, there is a point where individual accountability is entirely appropriate. Safety is an individual responsibility.

Our recent upturn in mishap rates could be telling us the traditional safety system, as we know it, will not get us closer to the lower mishap rates we must achieve. Traditional safety reporting systems may not be able to identify problem areas associated with new roles and operational taskings. We may need to look at less dramatic, more subtle indicators. We must move away from a mishap-investigate-correct reactive process.

Instead, we must take a more proactive position in preventing mishaps before they have a chance to occur — one that allows us to

Brigadier General Orin L. Godsey assumed the duties of the Air Force Chief of Safety on August 3rd of this year. He was formerly the Deputy Director, Command and Control, J3/J4, United States Strategic Command, Offutt AFB, NE.

make choices about how we employ our critical resources rather than have those choices dictated to us.

But one thing is clear — there is no magic bullet. Complex problems require new ideas working in concert to achieve a desired result.

Nearly 47 years ago, then Captain Chuck Yeager led us into a new era of aviation by breaking the sound barrier — an invisible demon in the sky many thought we would never overcome. But just as Captain Yeager used a rocket incorporating new designs and technologies to break the sound barrier, we too need a new vehicle of ideas and innovations to break the human factors barrier.

Operational Risk Management (ORM) principles offer the components we can use in our new safety vehicle to get us past the human factors demon. ORM tools and techniques must be developed for use at appropriate levels responsible for mission execution. We must not accept unnecessary risks, but must be willing to take appropriate risks when benefits outweigh costs.

Every pilot knows a flight is made up of a series of small corrections to keep the aircraft on course. Make too many corrections and you become erratic. Make too few and it could be fatal.

Likewise, unit cultures must also make course corrections. Risk assessment must not be something added on by the safety officer after mission planning is done. Risk management must be an integral part of the strategic and tactical planning process.

Not passing on "lessons learned" from mishaps for fear of tarnishing unit or personal reputations is conduct we can no longer tolerate. The "code of silence" must be broken. The "right stuff" needed in today's Air Force is a culture where individuals can pass on their mistakes so others can avoid them.

Leadership, discipline, and integrity are more critical than they have ever been. Commanders and supervisors must look beyond past achievements and continuously assess their units' ability to execute the unit mission. They must identify those who have been in the thick of things too long. They must distinguish between leaning forward in the straps to get a mission done and circumstances which are an accident looking for a place to happen. If an officer or airman needs to have his or her attitude readjusted — make that hard call. If a unit needs to go C2 for training or chronic fatigue, stand up and tell the boss when you can't take another tasking. Get your people the rest they need to stay in the fight.

Proper training is a vital part of mission focus. We must make time to train. Peacekeeping and humanitarian missions are vastly different roles than war-fighting. Our training programs must reflect new roles and missions, but we must always be ready to defend our freedom and national interests.

We must take time to define the issues. Thinking and planning are important parts of execution. We must clearly spell out rules of engagement for new taskings. Each situation is different from the last — vastly diverse roles we now engage in mandate that our people enter a new operation with an appropriate mindset.

In perspective, even though we're operating in one of the greatest periods of change the Air Force has known, we would have given anything to achieve today's mishap rate 10 years ago.

As Air Force Chief of Safety, I'll be working with many of you to identify new ideas which will help us break through the mishap barrier we have encountered — a system which will hopefully be more customer oriented and will help us restart a downward trend in the mishap rates for all categories.

One thing is certain: There are no easy answers and there is no magic bullet. ■

THERE I WAS

■ As a low-time private pilot, I had fallen into that niche where so many of us find ourselves — I had lost my mentor. Not taking lessons meant I had no "old head" to lean on and ask questions.

I usually rented planes from the FBO at the local airport. Knowing most civilians avoided the area east of the airport, and having no idea why, one day I decided to fly out that way to do some sightseeing.

The flight went just fine. I saw some country I hadn't seen before from the air and had a nice time. On the way back, however, things went sour in a hurry. About 5 or 10 miles east of the airport, I was about to call the tower for clearance into the airport traffic area when two F-16s went across my nose at about 200 yards. I swear I could count the rivets. Actually, I could tell they were screws and not rivets! The worst thing was the fact they were from my very own squadron.

Hoping to find out what happened, I visited the ops people. I was fortunate enough to find the two other pilots who had been there. They were very kind to me and explained they had been on an approach to the base. They also explained the lead had seen me and the wingman had not. Reviewing the tapes from the lead aircraft was very interesting. At least I hadn't shown up in the HUD picture!

Looking at the charts, it was easy to see why so many people avoided the area east of the airport — the instrument approach started that far out. I was fortunate that day, and today I can put this knowledge into a few statements.

■ Know the area where you're operating. This goes for everybody. Had I studied ALL the charts, I would have found the approach in that area.

■ I was flying VFR. VFR means **VISUAL** flight rules. Keep looking outside, in all possible directions, all the time.

■ Know your resources. If I had only tried, I would have found several old heads around the airport who would have been happy to share their knowledge with me. On the positive side, my squadron was a very valuable resource, and I was able to go there and get the entire story. ■

Our 50th Year

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page 4

page 9

page 14

SPECIAL FEATURES

REGULAR FEATURES

CONTRIBUTIONS

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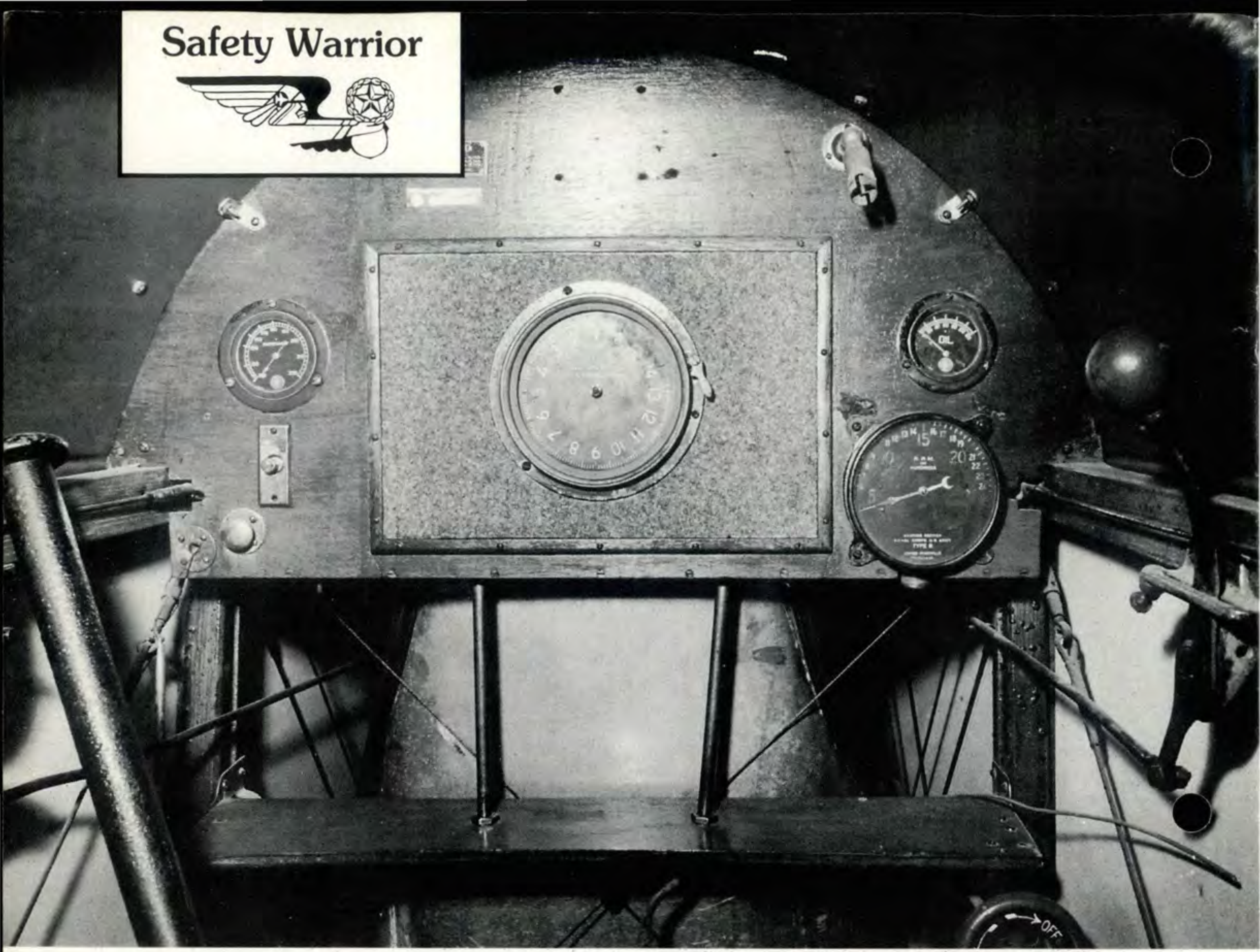


The Human Factors
History of Cockpit Displays

ROBERT A. ALKOV, Ph.D.
Southern California Safety Institute

In the early days of aviation, aircraft had open cockpits. The sound of the wind in the wire wing struts helped a pilot gauge airspeed.

■ In the early days of aviation, flight displays were very few and rudimentary. In the eighteenth century, balloonists used a barometer to gauge their height above the ground. This simple device used the principle of decreasing air pressure with altitude to allow the air placed inside the chamber at sea level to press against a bellows that drove a needle pointer. Thus, the altimeter was born.

As long as pilots stayed below 10,000 feet, there wasn't a problem. However, with the advent of the three-pointer altimeter came new opportunities for human error. Psychologists Paul Fitts, Walter Grether, and R. E. Jones at the Aero-Medical Lab at Wright-Patterson AFB in Dayton, Ohio, documented these errors immediately after World War II. Pilots were misreading 15,000 feet, for example, as 5,000 feet. This is a particularly dangerous error. With the advent of digital displays, these errors were eliminated.

The digital display can be read by a pilot three times as fast as the three-pointer display with little or no errors. However, the pointers on an altimeter yield qualitative, as well as quantitative, information. That is, the rate of change of altitude can be rapidly detected by the movement of the needles. Although a vertical speed indicator was provided, pilots still much preferred to have their digital readout of altitude supplemented by the pointer altimeter to

Photos courtesy of USAF Museum, Wright-Patterson AFB, Ohio

enable this rate of change to be rapidly detected.

The Wright brothers used a piece of string as an indicator of out-of-balance flight. This elementary device is still used today in sailplanes as a slip indicator. In those early days, aircraft had open cockpits. The sound of the wind in the wire wing struts helped a pilot gauge airspeed.

As it became more apparent airspeed was a crucial factor in preventing stalls at low altitude, the pitot tube airspeed indicator was developed. This device measured the pressure of the air coming into the pitot tube and displayed it as airspeed. Since these early planes did not stray far, they had only altimeters, airspeed indicators, and an engine RPM gauge for instruments.

As aircraft began to fly further afield, they required a compass for navigation and also a fuel quantity indicator to assure they would arrive safely. In World War I, they began to incorporate these instruments and several other large "steam driven gauges" in cockpits to inform the pilot as to the quantity and temperature of his engine oil, cylinder head temperature, etc. With the development of jet supersonic aircraft, the Mach and "G" meters were invented.

It wasn't until the invention of the artificial horizon, based on the principle of the gyroscope, that instrument flying became feasible. In 1929, Jimmy Doolittle became the first pilot to engage in "blind flying" by using the newly invented "Sperry Horizon." With his cockpit windows completely covered, he was able to take off, fly a circular route of 20 miles, and land from the place he had taken off.

The gyroscope works on the principle of the spinning top; namely, a rotating body will tend to orient with its axis perpendicular to the earth's

continued

World War I SE-5A fighter.

World War II era P-26.

As pilots flew farther from the airfield in increasingly more capable aircraft, they needed more information. Note the differences in displays from the WW I JN-1 (top left) to the A1/P-12E (above).

This 1944 P-39 has an altitude indicator mounted above the turn and slip indicator. Any guesses as to what's missing?

Looking for instrument needles to point in the same direction is an easy way to scan round-dial or analog gauges.

History of Cockpit Displays

continued

surface. Unfortunately, this device came with a built-in human factor design error, that is, one based on movement.

Since the horizon stayed parallel with the earth's horizon, and the pointer was fixed to the instrument, the pilot perceived the artificial horizon was moving and the little aircraft symbol was stationary during a turn. It is a normal human tendency to expect to see one's control inputs reflected in a movement of the aircraft's attitude in the direction of the control input. Instead, the movement of the artificial horizon is in a direction opposite to the actual turn. Many pilots, even the most experienced, have made control reversals using this device.

In the past, this factor of human expectancy has been ignored by engineers to the sorrow of many a pilot. Engineers, untrained in human factors, designed instruments which increased in value reading from right to left, from bottom to top, and counterclockwise. Instruments were placed out of sight of the pilot or in positions which increased their vulnerability to vertigo. Cockpit lighting was poor, and such factors as glare on the windscreen caused problems for night fliers. *No cockpit design should be approved without a review by pilots who are **current and qualified in type!***

Through flight training, we come to develop an instrument scan which helps us maintain situational awareness. At the beginning of our training, we tend to focus on one instrument at a time. This leads us into such errors as letting heading drift while attempting to maintain altitude.

In a two-dimensional world, such as driving a car, we are concerned with only speed and steering. But in the three-dimensional world of aviation, our task is greatly increased. As we progress through our training, we learn to smoothly integrate information from several different sources into a mental model through the development of instrument scan.

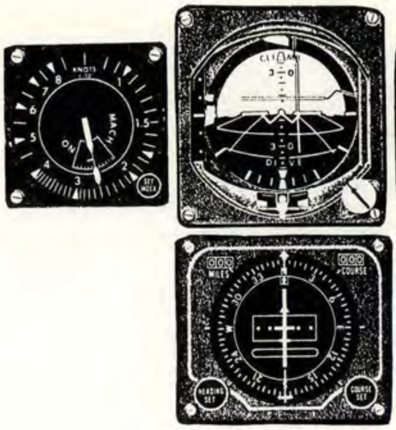
Humans process information from their senses serially, or one piece at a time. By integrating information from two or more senses, such as hearing and sight, we are able to parallel process. However, for the most part, we have to learn to use time sharing in our mental processes. Eventually, through trial and error, we learn to time share so well it appears we are processing several bits of information at once.

The low positioning of some of the instruments in this Curtiss P-1 could have led to vertigo.

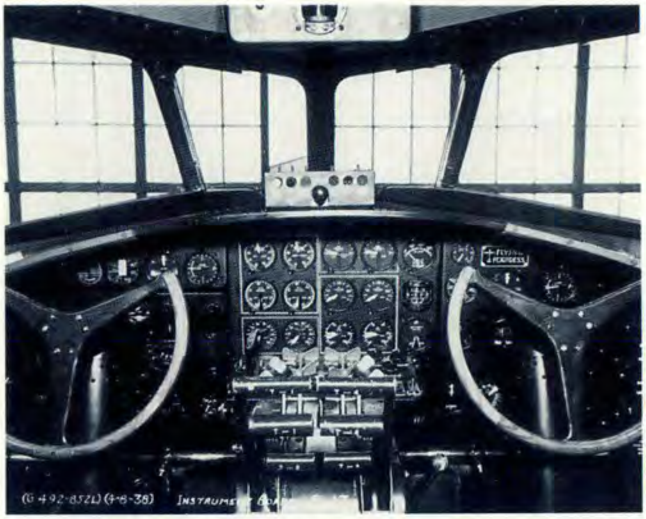
Under conditions of fatigue or stress, we humans tend to revert back to earlier modes of behavior. A study of fatigue in fighter pilots, done in the Psychology Lab at Cambridge University in England in 1939 by Sir Frederick Bartlett, demonstrated that after hours of flying in a simulated Spitfire cockpit, the pilot's scan broke down in the reverse order from which they had learned. The fatigued aviator focuses attention on one instrument at a time. However, through improved cockpit display layout, scan could be improved. Thus it was demonstrated, for optimum effectiveness, the cockpit should be designed around the characteristics of human beings rather than designing a cockpit, then trying to teach the pilot to use it.

During World War II, more aircraft and airmen were being lost to accidents than to enemy action. Part of the problem, as revealed by aviation psychologists, was a lack of cockpit standardization. Pilots would build up a habit pattern in a training aircraft, then find, upon transition to a fighter or bomber, the instrument arrangement and layout of controls was reversed or completely jumbled. These studies resulted in a standardization of cockpit displays which came to be called the "Basic T" arrangement.

The Basic T placed the artificial horizon in the center of the pilot's visual field with the airspeed indicator



The Basic T arrangement, minus the turn and slip indicator.



The cockpit display of a Boeing B-17.

and altimeter placed horizontally on each side of it (see figure above). Thus, deviation in the pitch attitude of the aircraft could be immediately detected by changes in airspeed, altitude, or the horizon indicator. Changes in roll or yaw of the aircraft could be detected by placing the direction indicator directly below and on the vertical axis of the attitude indicator. A turn needle and ball was placed below the direction indicator. This greatly improved the scan of pilots.

With the development of servo-driven avionics in the 1950s, it became possible to locate sensors remotely from the instrument panel, freeing up space. The cathode ray tube (CRT), developed as radar in the 1930s and '40s, became available as displays in the '60s and '70s. Thus came the development of the "glass cockpit."

The CRT eliminates the problem of parallax. This problem arises in a multicrewed aircraft with pilot and copilot seated side by side. When a pilot is seated off center, he/she sees the symbols at an angle from the pointers which results in a very different picture from what the copilot sees. The CRT is cheap, versatile, and can display colors, but it is heavy, bulky, and consumes a lot of electrical power. Flat panel displays, using liquid crystal displays (LCD), are being tested for replacing the CRT. LCDs are lighter, take up less space, and run cooler than the CRT but are sometimes hard to read when not viewed head-on.

In order for all aviators, regardless of their sitting height, to have a good view of displays which provide critical flight information, as well as a picture outside the cockpit, the requirement that aircraft cockpits be laid out around the pilot's "design eye" position was inaugurated. Thus, the pilot's seat must be capable of being adjusted up and down, forward or back, to allow all pilots the same view of the instruments, head-up displays (HUD), and the outside world.

The development of the HUD allowed the pilot to view other aircraft in flight or the runway on an approach while still furnishing data on flight parameters needed to maintain situational awareness. However, problems with lack of standardization of symbology and cluttering had to be resolved. Today the HUD is being certified as a primary flight instrument in some aircraft.

With the development of the "glass cockpit" and the HUD came new problems. The tremendous amount of information available threatened to overload the pilot's senses. Thus the requirement to "declutter" a display was born.

The overdependence on visual displays led to the development of displays using sounds, tones, and bells. The advantages of displays using sound are that they are omnidirectional, that is, you don't have to be looking in the cockpit at a display to get the warning. However, the abundance of warning sounds in the cockpit have led many pilots to turn them off as annoyances. In the modern jet cockpit, these sounds have been augmented by voice warning

F-106A cockpit.

B-29 cockpit.

History of Cockpit Displays continued

systems.

The voice warning not only has the advantage of being omnidirectional but can provide the pilot with information as to the nature of the problem and guide in its resolution. However, voice messages can interfere with cockpit communications and may not be heard over other communications. All of these sound-type displays need to have their tones or messages prioritized so they don't interfere with each other.

The human brain is much better at processing lines, patterns, and movement than it is at interpreting symbology. The use of symbols to represent actual events introduces the possibility of misinterpretation, another human error. Through the process of education and training, we learn to interpret symbols into meaningful information. The symbols you are scanning on this page convey meaning only because you have learned these symbols represent language, both the sounds and understanding of what the sounds mean.

The study of the meaning of sounds and symbols is semantics. The understanding of meaning which we learn to associate with sounds and symbols is known as semantic memory. Through training, we can retain an enormous amount of information in memory by organizing it in our semantic memory. Once information is stored in semantic memory, it is never lost although it might be temporarily blocked by interference with something learned previously or since, especially if the learning resembles our retained information. If, however, the symbology used is difficult to interpret or not standardized, problems can occur.

To maintain situational awareness, we don't need data so much as we need information which will help us form a mental picture of what's going on around us. This

North American P-51B instrument panel.

F-100D instrument panel.

mental model of our world (known as a "heuristic" in psychobabble) enables us to traverse our world on foot, in a motor vehicle, or flying an aircraft. If we overload a pilot with too much data, he/she may have trouble maintaining their mental model.

If we present the pilot with a confusing array of symbology to be interpreted, the mental model may be considerably delayed in forming. Thus, a mishap may occur before the mental model can be formed. This kind of error occurred on takeoff from Washington National Airport a decade ago. During the takeoff roll, the First Officer is heard on the voice recorder expressing doubt the aircraft was developing takeoff power. What he was seeing was a set of engine pressure ratio (EPR) gauges that was registering normal while other engine instruments were showing readings which didn't agree. The EPR gauges had frozen due to the cold weather and ice storm during that December morning. Instead of pointing at a bunch of numbers, the display should give the crew "go-no go" information on the takeoff. Thus they were unable to accurately form a mental model to reject the takeoff before they got airborne.

Proposals to fix human-error problems, such as those experienced by the Air Florida crew out of Washington National, include increasing automation in the cockpit. The advantages of automation in fuel efficiency, safety, and the lowered wear on engines, landing gear, and other components, make its use very compelling. Automation is beneficial in relieving pilot workload and reducing fatigue as well as small errors. But we know humans are superior to computers in unique situations such as emergencies requiring creative problem solving.

With increased automation, however, the pilot becomes relegated to a systems monitor, and we know human beings do not make good monitors. That's what we have computers for. Also, with increased automation, pilot proficiency suffers.

Automation has actually increased workload for pilots in many situations. It has led, too, to boredom and so-called "automation complacency." Airline crews, overrelying on their automation, have allowed aircraft to overshoot runways on landing, deep stall in flight, or fly into terrain when they have failed to monitor their aircraft's instruments. Automation also leads to failure to look out the cockpit window for conflicting traffic. Efforts at installing automated collision avoidance systems are already underway in the air carrier world.

No doubt the design of future cockpits will see an increase in automation. Artificial intelligence is being developed which will rival the decisions of highly experienced aviators. As these systems are developed, they will need to become more error-tolerant. Error-checking mechanisms will need to be incorporated to prevent pilot error. The overall aviation environment will have to be redesigned to be less vulnerable to error.

If human engineering design is done correctly, less emphasis for training on complex systems will be required. Although expensive initially, such designs should prove their worth in saving lives and very valuable equipment. ■

The ADVANCED Instrument Flight Course

or Instruments 'R' Us

CAPT KEVIN JONES
93 OSS/DOI (AIFC)
Castle AFB, California

The AIFC is a graduate-level course designed to increase unit combat capability by training graduates to act as unit-level instrument experts. This isn't a glorified 60:1 school, it's a repository for the Air Force's corporate knowledge on worldwide instrument flying.

■ One important reason the United States Air Force is the best air force in the world is our ability to fight anywhere in the world — rain or shine. Our all-weather capability is directly proportional to the instrument skills of our pilots.

ACC's Advanced Instrument Flight Course (AIFC) at Castle AFB is dedicated to preserving our combat capability by training the best instrument pilots in the world. In fact, our charter is to "increase com-

continued

The ADVANCED Instrument Flight Course

continued

Although somewhat dated, the T-40 and the T-40 simulator staff provide a convenient "laboratory" where students can apply instrument flying principles in a real-time environment.

bat capability and reduce aircraft mishaps through increased instrument knowledge."

Here's a little background on how AIFC started. Those of you who have been flying for a long time probably remember when the Air Force had a school at Randolph AFB, Texas, called the USAF Instrument Pilot Instructor School, or IPIS. IPIS was an institution devoted to producing experts in instrument flight through academic, simulator, and in-flight instruction in the T-38. Due to budget constraints, IPIS was closed in 1979.

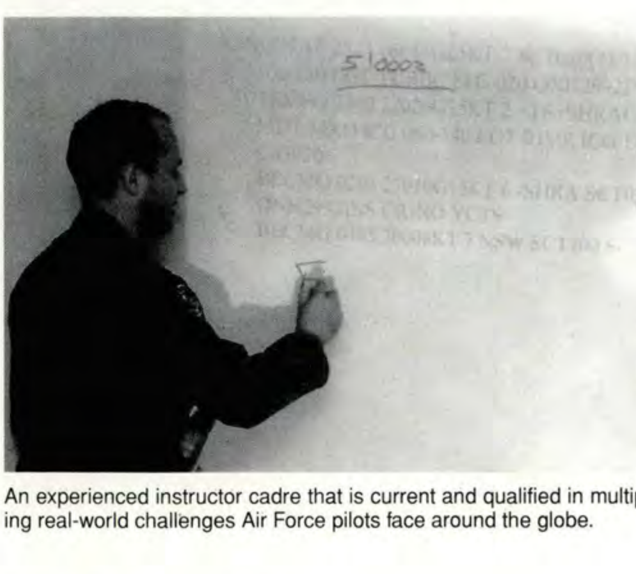
Not long after the closure of IPIS, senior Air Force leaders became extremely concerned about evaluation trends showing a decrease in instrument knowledge. Their concern peaked in early 1981 when several aircraft mishaps and incidents were attributed to lack of instrument knowledge. Later that same year, CINCSAC directed the opening of the SAC Instrument Flight Course (SIFC).

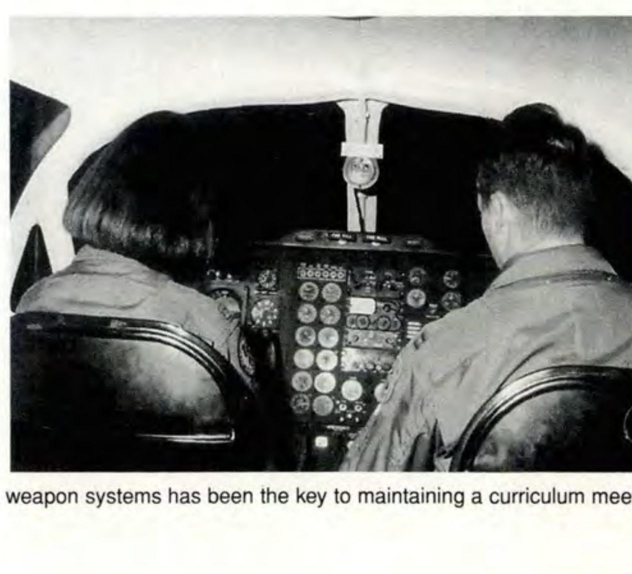
During the Air Force's MAJCOM reorganization in the spring of 1992, SIFC was moved to ACC and renamed the Advanced Instrument Flight Course. Although SIFC was primarily devoted to SAC aircrews, AIFC's classes have been expanded to admit pilots from any weapons system.

The threefold mission of the old SIFC remains unchanged for AIFC now:

- To increase combat capability by reducing aircraft mishaps through increased instrument knowledge
- To provide a central point of contact and coordination (within the Air Force) for all instrument matters
- To provide graduates to act as unit-level instrument focal points for both aircrews and the wing staff

The Advanced Instrument Flight Course is a 13-day program dedicated to making our graduates the instrument experts in your units. In fact, AIFC is the only school in the Department of Defense offering advanced instrument education, and our graduates constantly affirm the value of advanced instrument training in their course critiques. Over 90 percent of our graduates rate the course "Outstanding," and remarks like "Best course in the USAF" and "Every pilot should attend AIFC" are commonplace.





An experienced instructor cadre that is current and qualified in multiple weapon systems has been the key to maintaining a curriculum meeting real-world challenges Air Force pilots face around the globe.

The course consists of 89 hours of academics and 11 hours of simulators. The curriculum, often compared to the proverbial "firehose," covers every aspect of instrument flight as it applies to worldwide operational flying ranging from TERPs to advanced approach breakdowns, ICAO procedures, ALTRVs, low-visibility landings, and windshear. These are just 6 of the 26 academic subjects covered.

AIFC graduates 156 pilots annually from all the MAJCOMs, ANG, and AFRES as well as several sister service and foreign exchange pilots. The AIFC perspective is from the cockpit, and with a maximum of 12 students per class, student participation in all classes is strongly encouraged. The course provides a continual application of precision instrument flying based on concentrated classroom instruction and application in the simulators. Techniques such as the use of the 60:1 rule become second nature, and the knowledge you gain will give you many "tricks of the trade" which are teachable, so you will not have to rely on TLAR ("That looks about right") or quotes like "You'll get the hang of it."

The AIFC experience doesn't end after graduation. AIFC continues to be on the cutting edge of instrument evolution by keeping up to date on the ever-changing instrument arena as it applies to the USAF's mission.

The course addresses new innovations in the flying world such as TCAS, Mode S, GPS, MLS, and the latest windshear detection technology. AIFC graduates are expected to return to their units and spread the knowledge to their unit's aircrew members by any means available — prebriefs, in-flight pointers, hangar flying sessions, or the Instrument Refresher Course. Sending a pilot to AIFC is an investment every unit must make — the rewards will be safer flight operations and enhanced combat capability for the entire unit.

Currently, the AIFC staff consists of seven senior instructor pilots from the B-52 and KC-135. The staff's combined flight time is over 20,000 hours with nearly 10,000 hours logged as instructor pilots in a variety of aircraft (T-37, C-21, B-52, and KC-135). A majority of their instructor time comes from CCTS and UPT, and several have civilian flying credentials (commercial and ATP). The staff gains its technical expertise by attending seminars on subjects such as windshear and GPS and maintaining graduates of the USAF's TERPs course, Airspace Management course, and the Altitude Reservation course.

AIFC is a central point of contact for Air Force instrument matters. We maintain liaison with all of the MAJCOMs, the FAA, the NTSB, the Inter-American Air Force Academy, and the Canadian Instrument Check

continued

What makes the AIFC experience so unique is the seminar format. Each student is already an experienced aviator — it's the synergistic effect of different weapon system backgrounds that makes this school the only one of its kind in the DOD.

The ADVANCED Instrument Flight Course

continued

Pilot School. We confer with the Air Force Flight Standards Agency (AFFSA) at Andrews AFB for clarification on the latest instrument guidance and procedures — the FSA makes the policy, we teach it. AIFC instructors are always ready to answer your questions or help solve an instrument problem. If we can't answer the question for you, we will find someone who can.

The school's overwhelming success has become well known, and we are working on several ideas to expand its influence and increase our productivity. Plans are in the works for AIFC to move again. We are moving from ACC to AETC, and the school should move to Randolph AFB in the near future.

Once the move to Randolph AFB and AETC is complete, we hope to double the class production. Each class will still be limited to 12 students to retain that "intimate" atmosphere — we'll just teach two classes at once.

We want to expand the faculty and the students to include all weapons systems — yes, even you "fighter" guys. Recently, we ran a test class with fighter pilots, and we've had a smattering of other fast movers over the years. They've all given the course rave reviews just like the "heavy" guys.

If you are interested in attending AIFC, see your local training section. They should know how to get a class slot for you. Also, we will be looking for experienced major weapon system IPs to fill the staff once we move to AETC at Randolph AFB. It will be a flying job, so keep an eye on the bulletin board if you'd like to become an AIFC instructor.

AIFC is here to serve your instrument needs. Please feel free to call us anytime at DSN 347-4571. Fly safe, fly smart. ■

CURRICULUM

Students attending the Advanced Instrument Flight Course (AIFC) get 89.0 hours of academic instruction and 10.5 hours of simulator instruction. Academic courses cover the following subjects:

- Airspace
- Air Traffic Control (ATC) Procedures
- ALTRVS
- Approach Lighting Systems
- Arrival Procedures
- Circling Approaches
- Departure Procedures
- Development of Instrument Procedures and Techniques
- Enroute Weather
- Flight Plans
- Flight Rules Seminar
- Flight Information Publications (FLIP)
- Holding
- International Civil Aviation Organization (ICAO) Procedures
- Instrument Procedures
- Instrument Refresher Course Program
- Landing Considerations
- Low Altitude Approaches
- Missed Approach Procedures
- Navigation Aids (NAVAIDs)
- Notices to Airmen (NOTAMs)
- Preflight Weather
- Spatial Disorientation
- Terminal Procedures (TERPS) Design Criteria
- Wind Shear

STUDENT QUALIFICATION

Student qualifications can be found in ACCR 51-37, paragraph 6, "Since AIFC is an intense graduate level advanced instrument course, pilots selected to attend AIFC should be instructors current in their aircraft. However, units may send experienced pilots or, for multiplace aircraft, aircraft commanders with 6 months experience as an AC who either currently serve as unit IRC instructors or will serve upon completion of AIFC. Students must be nominated to attend AIFC by their unit commander. They must complete pre-course materials prior to arrival at AIFC. Other nominees may attend with prior approval of HQ ACC/DOTF. Because the opportunity to attend AIFC is limited, units must make maximum use of their AIFC graduates. They should be used in positions requiring instrument flying expertise for a minimum of 1 year after AIFC graduation."

That's the book answer. What we are looking for are instructor pilots or senior aircraft commanders about to upgrade to instructor. Graduates should be placed in positions where they can best spread the knowledge they gained by attending AIFC. AIFC is a graduate level course of instruction not suited for pilots any less experienced in the flying world.

TRAINING ALLOCATIONS

AIFC slots are allocated to the MAJCOMs by HQ ACC/DOTF. Unit training representatives should contact the appropriate point of contact to request AIFC allocations for their units. For AMC pilots, the point of contact is HQ AMC/DOTF (DSN 576-5614). For all other pilots, contact HQ ACC/DOTF (DSN 574-7991).

If you need any more information, feel free to call!

continued

Whatever Happened to the Instrument Flight Center?

LT COL EDWARD D. JOHNSEN
AFFSA/XOI
Andrews AFB, Maryland

■ Your old flying squadron isn't the only unit in the Air Force that has restructured, reorganized, and relocated. Remember those "instrument experts" some of your fellow aviators would call when Stan Eval was trying to give them a "hit" on an instrument check ride? The ones who actually write 60-16 and 51-37?

Well, the "old" Air Force Instrument Flight Center (IFC) has gone through some reorganization changes along with most everyone else. Not only have we moved from Randolph AFB to Andrews AFB, we've also acquired a new name. We're now part of the **Air Force Flight Standards Agency** (AFFSA); specifically, we're the AFFSA Directorate of Operations (AFFSA/XO).

Let's refresh your memory on some of the things the IFC did that we now do at the AFFSA. We've already mentioned we're the writers of **AFR 60-16**. If you want to win a beer at the bar, bet someone they don't know the technical designation of *General Flight Rules*. The old "60-16" will soon be called AFI 11-206. While we're on the subject of regs and manuals, some of the biggies the AFFSA is also responsible for include **AFM 51-37**, *Instrument Flying;* **AFM 51-12**, *Weather for Aircrews;* and **AFM 60-19**, which provides guidance for the *Instrument Refresher Course.* All these manuals are undergoing rewrite and will soon have new designations. As we get closer to publication, we'll get the word out about the changes. If you ever need an interpretation of information found in any of these publications, or if you need a "ruling" to help settle a friendly wager, give the guys in AFFSA Flight Standards Division a call at DSN 858-2126.

Have you ever looked at an instrument approach plate and wondered why a procedure was designed with 14 step-down fixes or why the final approach course was 15 degrees from runway heading? The base TERPs specialist is a good person to contact for questions regarding a specific procedure, but he can sometimes be harder to find than the regular crew chief! If you have general questions regarding approach procedure design criteria, give the folks in AFFSA Instrument Standards Division a call at DSN 858-2103. Their TERPs specialists can explain in aircrew lingo why approaches are designed a particular way or what agency or person is responsible for the currency of an airfield's approach data.

The aeronautical information specialists in the Instrument Standards Division are responsible for all production facets of Flight Information Publications (FLIP). The FLIP products most of you are familiar with include instrument approach plates, IFR/VFR Sups, the Flight Information Handbook, en route charts, General Planning and Area Planning, material you regularly use to plan and fly your missions. So if you have any questions or problems related to FLIP, give these people a call.

The AFFSA has pilots representing most major weapons systems. Part of their job is to ensure their particular aircraft's perspective is considered during development of new instrument flight procedures, flying regulations, and navigation systems. We also have technicians who are intimately familiar with approach landing systems, as well as specialists in air traffic control, airfield management, future navigation systems, weather, terminal approach procedures, and NOTAMs.

In short, we are involved in just about every part of the flight operations cycle, from initial mission planning to final shutdown and flight plan closeout. If we don't have the answers to your questions, we generally know who does, and we'll be happy to get the answer for you or steer you in the right direction.

In a nutshell, the heart of the old Instrument Flight Center is still beating. Only now it's the **Air Force Flight Standards Agency** who stands ready to serve the instrument flying community. ■

HIGH TECH

MR. GREG BARBATO
Engineering Psychologist

■ Throughout the conflicts of the next decade, long-range sensors, data-linked real-time intelligence, increased use of "off-board" information, and cooperative operations tactics will affect a variety of Air Force missions. For example, attacking hardened or mobile ground targets at night and in adverse weather while simultaneously monitoring and surviving against increasingly sophisticated threats will put severe demands on the aircrew. The introduction of new and maturing capa-

COCKPITS

Photos by the Wright-Patterson AFB Area B Multimedia Center – 645 MSSQ/MSI VG

bilities will also increase the complexity of the pilot's environment if that information is not presented correctly.

As a result, pilot ability to use information inside the cockpit could become a limiting factor of mission performance. To continue to ensure mission success, new technologies must be developed to simplify cockpit operation and to expand pilot situational awareness.

What We Are Doing About It

The Wright Laboratory Cockpit Integration Division is pursuing technology assessments to evaluate pilot abilities for performing projected 1998-and-beyond fighter and transport missions that demonstrate measurable improvements in productivity and effectiveness. The technologies to realize these improvements will eventually provide real-time target, threat, and weather information in the cockpit.

These technologies will help the pilot:

- Replan the mission when necessary to take advantage of targets of opportunity.
- Attack mobile ground targets, as well as multiple airborne targets, in cooperation with friendly forces.
- Conduct precision airdrop for troop resupply and reinforcement or humanitarian aid with high probabilities of mission success and aircrew survival.

Simultaneously, the Wright Lab study is designed to evaluate specific technology applications for allowing minimum crew sizes (e.g., single-seat fighters and two-seat transports) to perform their missions efficiently and safely.

The Crew System Integration Laboratory (CSIL) is a Wright-Patterson AFB Wright Lab facility consisting of five cockpit simulators and supporting hardware. These simulators (see The Simulators) and associated programs are the testing arenas for this research which will allow us to provide the pilot with the future high tech cockpit to get the job done. Let's take a look at what we have to look forward to.

Transport Aircraft Cockpit (TRAC) Program [1]

The TRAC Program is a multiyear transport cockpit design, development, simulation test and evaluation effort to support Air Mobility Command-identified cockpit modernization requirements to achieve mission enhancements and reduced crew sizes. Typical program activities include mission and requirements assessments, crew-vehicle interface design and development, simulation, and crewmember test and evaluation.

One critical aspect of the program is frequent and substantive user participation occurring not only during

continued

[1] The TRAC Program uses the TRAC simulator.

HIGH TECH

The Simulators

The Simulators

■ **The Transport Aircraft Cockpit (TRAC) Simulator** is based on the C-141 geometry, but simulator hardware and software architecture is based on rapid-prototyping requirements. Thus, TRAC crew stations are outfitted with components such as large, touch-sensitive, multipurpose display (MPD) monitors and software-generated switches and controls.

The formats (pictures) shown on these displays can be quickly reconfigured to represent alternative design concepts or even totally different instrument panel layouts. Full mission and full task simulation is emphasized in the TRAC Program. Extensive development is typically required for each test to create realistic sensor and aircraft characteristics and authentic mission scenarios.

■ **IMPACT and TACS The Integrated Mission Precision Attack Cockpit Technology (IMPACT)** fighter cockpit simulator is a 27-inch, full color MPD with a touch-sensitive overlay. This MPD is used to provide virtual images of front panel displays and controls, yielding the flexibility to simulate a variety of electronic and mechanical displays as well as allowing virtual switch activation and other interface functions.

Virtual switch activation combined with IMPACT's hands-on-throttle-and-stick (HOTAS) switches provide the pilot with full system control.

■ **The Tactical Aircraft Cockpit Simulator (TACS)** is also a fighter cockpit simulator and includes three, full color, 6" x 6" MPDs arranged side by side across the front panel. A smaller, touch-sensitive, "upfront" controller is mounted directly above the center MPD. Programmable display pushbuttons, MPD bezel-mounted switches, and HOTAS provide the TACS pilot with full system control. Both IMPACT and TACS present headup display symbology and a computer-generated, out-the-window scene on high-resolution, high-brightness, rear-projection screens situated in front of each simulator.

IMPACT's current point design is two 10-inch square MPDs arranged side by side (in the virtual environment), and TACS replicates almost exactly the configuration of the front seat of an F-15E. The TACS cockpit serves as the performance baseline for the near-term (within 5 to 10 years) advanced concepts being researched in IMPACT. The simulators can be flown as separate cockpits (TACS for air-to-air and IMPACT for air-to-ground missions) or they can be "linked" together as a two-ship, cooperative attack fighter element.

■ **PCCADS and MAGIC** The Panoramic Cockpit Controls and Displays System's (PCCADS) primary feature is a 300-square inch, tailorable, full-color MPD with a touch-screen overlay. Required front panel controls and displays are represented as virtual images on this large screen monitor. PCCADS also incorporates a pilot head tracking device, a connected speech recognition system, and a projection system that is used for presentation of headup information and an out-the-window visual scene.

The Microprocessor Applications for Graphics and Interactive Communications (MAGIC) design provides a cockpit environment that is not virtual and that maintains experimental consistency, particularly with respect to the positioning of the controls and displays relative to a pilot. MAGIC's capability and flexibility result from its composition of a large number of off-the-shelf peripheral devices, each offering some specialized capabilities.

Both PCCADS and MAGIC are generic, single-seat fighter cockpit simulators used to host the evaluation of new display formats and technologies that are targeted for integration into aircraft approximately 10-15 years into the future. ■

testing, but also during requirements and design development, test scenario development, and test plan preparation.

The current focus is to conduct pilot-in-the-loop evaluations of existing and near-term technologies such as the Intra-Formation Positioning System, Autonomous Landing Guidance System, real time display of intelligence and other off-board information in the cockpit, and helmet-mounted and headup display systems. Candidate subsystems are integrated into the TRAC simulator, and evaluation emphasis is placed on determining pilot and navigator workload, determining the effectiveness of the pilot-vehicle interface, and incorporating the requirements for transport cockpits.

Over the past 2 years, the TRAC

Program has explored advanced concepts for both strategic and tactical mobility operations as well as supported Warner Robins Air Logistic Center programs to develop a "glass" cockpit for the C-141 with standardized electronic primary flight displays.

The IMPACT Program[2]

Crew size reductions, along with increased information management requirements as well as the increased danger of battlefield threats, will challenge the future fighter pilot's ability to assimilate available information and act appropriately. Also, the capability for operations in any part of the world at night and in bad weather is becoming increasingly important. We must realize, too, that single-seat versions of fighters to perform missions currently requiring two crewmembers demands new crew systems that fully exploit human performance capabilities without exceeding workload limitations.

The objective of the IMPACT Program is to match these avionics advances, increased mission requirements, and reduced crew complements with parallel improvements in cockpit technology, new cockpit concepts for fighter aircraft, and to assess each design's operational utility and pilot acceptance.

IMPACT evaluations consist of pilot simulations of cockpit design alternatives and are structured to collect and analyze aircraft, pilot, and mission performance data. These data are used to determine which options are the most mission- and cost-effective. They are also used to establish design specifications for avionics modifications and all upgrades.

IMPACT's technology integration focus is on systems with an availability date of 1998 or sooner. A tactical situation display for the single-seat fighter strike mission is under development and uses a digitized map to show the route the pilot must follow to complete the mission. This map simulates information fusion from a variety of sources: pre-mission planning inputs, onboard sensor data, and off-board data-linked information.

It allows the pilot to plan or modify an attack or escape route miles away from the strike point and uses many forms of information requiring minimal pilot mental interpretation of complex raw data. The map shows digitized waypoints, landmarks, and terrain features and has both expanded map views and look-down target area views that will eventually be combined with look-ahead target area views.

The ACTCC Program[3]

The Advanced Crew-Tailored Cockpit Concepts (ACTCC) Program conducts research and development in the areas of advanced attitude and spatial awareness displays for early 21st-century aerospace vehicles. Specific research focus includes the following:

- Combination of attitude information as well as mission essential information to facilitate pilot situational awareness, and
- The use of three-dimensional displays and unique control devices to interact with these displays to enhance pilot situational awareness.

The ACTCC Program primarily conducts pilot-in-the-loop evaluations in either of two cockpit simulators, MAGIC and PCCADS, and focuses its integration efforts on technologies that will be available for aircraft insertion 10-15 years into the future. Its analysis emphasis is in maintaining pilot workload at acceptable levels.

Current research is focused on the use of voice recognition for controlling specific cockpit functions. It also focuses on using three-dimensional perspective on visual displays for allowing the pilot to preview the target area as a simulated flyby and for quickly designating targets in cluttered environments.

ACTCC voice recognition studies are yielding 98 percent accuracy rates in the lab environment and, in 1995, the Cockpit Integration Division will team with NASA to flight test the voice recognition system in an OV-10 platform. The flight test will place the voice system in a high noise, high vibration, and medium G-force environment (up to 5 Gs). Upon successful completion of these flight tests, the voice system may move on to weapon platform testing (i.e., F-16, AC-130, etc.).

The Future

We are doing something to help future aircrews get their job done. Through Wright Labs' extensive research, development, study, and practical application, these high tech cockpits will be designed to ensure mission success, simplify cockpit operation, and expand situational awareness. ■

[2]The IMPACT Program uses the IMPACT and TACS Simulators.

[3]The ACTCC Program uses the PCCADS and MAGIC Simulators.

Flight Inspection:

CAPTAIN PETER W. GRETSCH
AFFSA Flight Inspection Center

Get ON That Glidepath!

■ You have the glidepath nailed and are expertly nudging your aircraft onto the localizer course. There! All trimmed up, 1 mile from touchdown, and you relax — a perfect ILS approach, uncoupled, of course. But wait. Now you're drifting a bit above glidepath.

Do you blame this minor aberration on wind gusts, temperature inversion, or perhaps the ILS's increased sensitivity as you get nearer the antennas? The ghost of your first flight instructor haunts you. "Your cross-check must get even sharper as you get closer to the runway . . . This is no time for your concentration to wander."

These are common reactions to a last-minute departure from the perfect ILS approach. But are you confident enough to cast away all self-doubt and blame it on the "screwy glide slope"?

Occasionally there is some truth to this accusation. A *published* 3° glide slope doesn't have to be exactly 3° . Try to find that statement in your old copy of AFM 51-37. Nowhere does it say the glide slope can't get a little steeper somewhere along the approach.

Did you know a 3° CAT I glidepath angle may fall anywhere within 2.775° to 3.3° ? (The tolerance for a *newly commissioned* ILS is a tight 2.95° to 3.05°.) Few navigation facilities, i.e., localizer, glide slope, TACAN, VOR/DME, NDB, microwave landing systems (MLS), can transmit a perfect electronic signal to all points in space. As the pilot, it's your job to fly the published 3°glidepath, not to know its limits. The *flight inspection* aircrew's job is to verify the NAVAIDs and radar systems you rely on for the safety of your crew and aircraft.

Who is the Flight Inspector?

Flight inspection teams are made up of civilian FAA and USAF personnel who travel across the country and around the world in search of potentially unsafe NAVAIDs and radar systems. We are very user oriented. We do not inspect the ability to safely perform the mission or aircraft airworthiness. Instead, we check the integrity of facilities you use to get from chock to chock.

At last count, there were over 12,500 domestic NAVAIDs, mostly VOR/ DMEs, TACANs, NDBs, and ILSs. Each NAVAID was rigorously calibrated, adjusted, and checked when it was first put into use. After the initial certification, they are subjected to a schedule of *periodic inspections.*

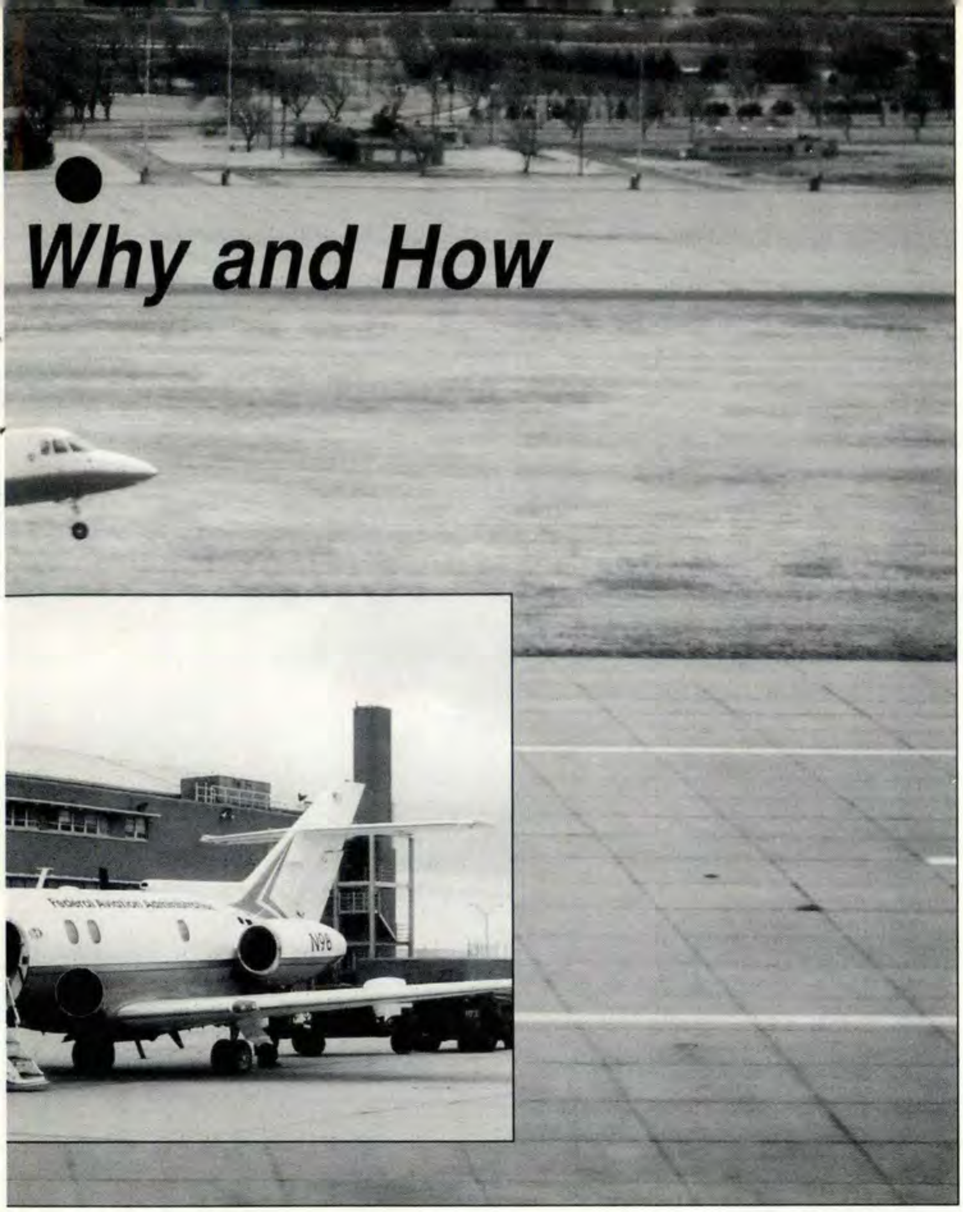
Performing the flight inspection job is a fleet of BAe 125-800s, Beech 300 Super King Airs, and Sabreliner 40s/80s, located at seven national FAA offices. USAF flight inspectors fly only the BAe-125 (military designation "C-29") out of Oklahoma City. All are equipped with multiple precision-calibrated NAVAID receivers, computers, printer/plotters, and oscilloscopes.

Some aircraft have modifications to inspect MLS, global positioning system procedures, and LORAN-C. The specially trained aircrew — two pilots and an electronic technician — digests the large mass of collected electronic data. Their special radio call sign is "Flight Check ##."

Why Flight Inspection?

NAVAIDs are routinely checked by maintenance experts using ground-based monitors and test equipment. However, ground tests don't record what an *airborne* aircraft actually sees. Engineers can tweak transmitters and antennas until a perfect signal emanates at the source. On the way to a 5-mile final, however, there may be electronic interference, disturbance from build-

Why and How



ings or terrain, and disruption by ground water tables. The flight inspector bridges the gap between a NAVAID's designed performance specifications and its usability to the instrument pilot.

The most important part of our job is verifying that the electronic signals you use to fly a certain ground track or a specific descent gradient are within standard tolerances. This is important because the people who design and draw your instrument procedures — Instrument Approaches (IAP), Standard Instrument Departures (SID), arrivals, holding patterns, etc. — use the same standards to ensure your aircraft doesn't hit anything other than air.

Once a NAVAID's signal deteriorates out of tolerance due to age, severe weather, human error, nearby construction, or tree growth, etc., published procedures may no longer guarantee obstacle clearance.

A Quick Look at How Flight Inspection is Done

The flight inspector's first task is gathering data on a NAVAID's signal propagation in specific areas around the antenna and on associated IAPs. We then analyze and compare the data to standards for each NAVAID type. For example, while you are verifying your VOR receiver is within ±4° of the ground checkpoint, flight inspectors make sure the VOR transmits a quality signal to within ±2.5° of the correct magnetic azimuth. The *correct* azimuth is determined by combining map study, ground references, INS/FMS positioning, and sometimes GPS inputs.

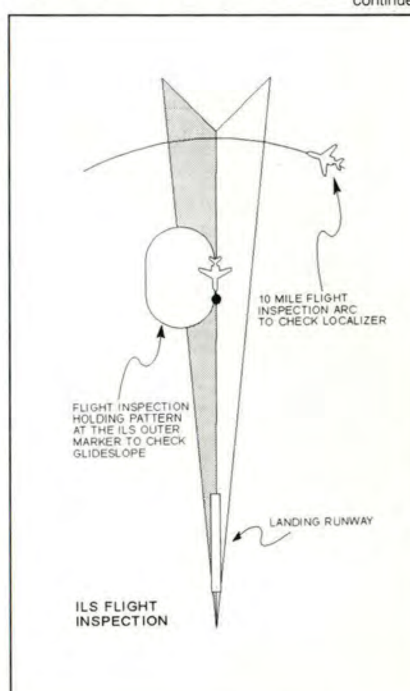
Signal *quality* is measured and analyzed on an airborne plotter/ printer and computer. A typical pilot need not be concerned with the many parameters of signal quality (e.g., the microamps, microvolts, signal polarization, frequency modulation, course excursions/reversals from average, etc.), as long as the end result is a stable, reliable course needle.

For TACANs, VORs, and NDBs, flight inspectors orbit the antenna at radii from 5 to 40 miles. They verify minimum signal strength and radial accuracy around all 360°. ILS facility checks require less airspace and don't require complete orbits. However, because of the precision approach, they require more thorough analyses and tighter tolerances of signal patterns in the approach area.

Next, the most important test: How well does the NAVAID support every associated instrument procedure? Sometimes the same approach is flown half a dozen times to answer this. Finally, there are ground/airborne checkpoints, voice/ID signals, standby equipment, and another handful of ancillary parameters to inspect.

The flight inspection team, along with maintenance personnel, will then make any electronic or physical adjustments needed to bring the fa-

continued



Flight Inspection: Why and How continued

cility up to standards or to make it more precise than before. The signal-in-space is then *certified* by signature of the flight inspector on an official report.

A typical periodic inspection of an existing facility may take a few hours of flight time, while the commissioning of a new VOR or ILS may take a few days. There are few "typical" inspections because each one is shaped by the facility's condition, weather (many checks require VMC), and ATC's ability to work the flight profiles in among the general traffic flow. Murphy's law of scheduling often requires us to inspect the ILS to the "wrong" end of the active runway, causing us to shoot multiple opposite-direction approaches against the normal flight pattern.

Flight inspection 10-mile arcs across the localizer course (at FAF altitude) may delay your normal letdown to final. We may have to temporarily make it unavailable for general use. We also may ask ATC to sterilize the area in front of the localizer antenna (in the air and on the taxiways) during critical "recorded run" approaches. These disruptions are paid back to the flying community in terms of a safe, reliable NAVAID structure.

Types of Inspections

The flight inspector performs many other types of inspections. *After-accident* inspections are performed immediately after a mishap at the request of the accident investigator. This check determines whether a NAVAID or published procedural error contributed to the accident.

Special inspections are performed to restore a NAVAID which has been out of service for scheduled repair or unscheduled acts of nature. Hurricanes, tornadoes, and large-scale flooding often take out vital NAVAIDs when they are most needed.

Last, flight inspectors are dispatched to investigate and troubleshoot user complaints from pilots, ATC, airport operators, etc., about substandard facility performance.

The flight inspection team has three other responsibilities. First, the published IAP is inspected and certified on its own, regardless of how the NAVAID supports it. The flight inspector is the last quality control for procedural correctness and flyability. Taken into consideration: Can a single-seat pilot fly this IAP, with cockpit workload, frequency changes, numbers of course/altitude changes, readability of the approach plate, etc.?

Second, the airborne flight inspector makes sure the controlling obstacle of an IAP is actually where the cartographers think it is. Periodic checks are made to ensure no new obstacles affect the existing IAP minimums.

Third, the flight inspection team performs continuous surveillance of *all* aeronautical services. They report substandard or hazardous conditions related to runway/taxi markings, airport construction areas, airfield/approach lighting, and even shipboard TACANs for the Navy. They also monitor quality control for air traffic services. These include PAR/ ASR approaches, clearances, aircraft separation and spacing, flight plans, communications, flight service stations, NOTAM accuracy and availability, weather bureau services, and published information on procedures or airports.

Where Does the Air Force Fit In?

The Flight Inspection Center (FIC) is a little-known unit under the command of the USAF Flight Standards Agency. FIC pilots and senior enlisted airborne technicians serve as the USAF's liaison to the FAA's International Flight Inspection Office in Oklahoma City.

During peacetime, FIC aircrews are integrated into the FAA's flight inspection schedule to perform missions at civilian and military facilities. Aircrews are mixed — USAF and FAA personnel work together. FIC's primary mission, however, is *combat flight inspection* in support of national mobility plans during wartime, crises, contingencies, and JCS exercises.

When U.S. forces deploy, FIC aircrews can be tasked to inspect integrity and safety of existing NAVAIDs on foreign soil. This can be a politically sensitive issue. We are in a sovereign nation checking whether their navigation/radar systems need adjusting to U.S. standards.

Additionally, the Air Force, Army, and Marines deploy their own versions of mobile TACANs, PAR/ASR radars, and NDBs. These systems must receive commissioning and periodic inspections which are just as demanding as those done for peacetime aviation in the States.

USAF combat flight inspection has left a historical trail through Vietnam and Southeast Asia, Grenada, Panama, and Desert Shield/Storm. Recently, the FIC has commissioned mobile TACANs and PARs in Somalia, inspected French PAR approaches in Sarajevo, and checked foreign and mobile equipment for the relief effort around Rwanda.

A Safe Navigation System to Rely On

Hopefully, your confidence in the complex matrix of navigation aids which safely and efficiently deliver your aircraft to its destination in almost any type of weather has been increased. You can trust this NAVAID system is continually inspected, analyzed, and test flown by a team of flight inspection professionals which includes the USAF's own. ■

THERE I WAS

Friendly Fire on the Flightline

CMSgt Walter C. Brauer
AFSA/SENA

■ The CH-3 had stood alert all night and now had to be readied for an early combat mission. I was dispatched with another airman, named Danny, to ensure the CH-3's 7.62 mm minigun system and backup M-60s were ready. Should be a piece of cake if the guys who put the bird on alert did their job.

The CH-3s of the 21st Squadron had unique minigun systems. A turret from a Cobra gunship was grafted to an 8,000-round ammo box. This all mounted where the CH-3's left or right external fuel tank normally fit.

The missing fuel tank(s) did present a range problem, but NKP was actually closer by air to Hanoi than any base in South Vietnam, and these birds weren't going that far.

When Danny and I arrived at the CH-3, the crew chief already had the APU running. Danny began to dearm the minigun, which consisted of removing panels, separating the ammo belt from the gun's feeder delinker unit, then manually cranking out the 12 rounds that were left in the feeder delinker. I opened the ammo box to inspect and top off the ammo.

I noticed the crew chief appeared from the other side of the aircraft and spoke with my partner. They both climbed into the cabin for a few seconds, then the crew chief walked off in the direction of the line shack about 100 yards away. He left the APU running.

I completed buttoning up the ammo box and looked for Danny. He was still in the cabin and had set up the gun sight. Now we had to determine if the gun and the gun sight were synchronized, then dry fire the gun in both low and high fire mode.

"My heart jumped as I noticed the empty link hanging out of the feeder delinker unit. The gun was not cleared! There were still 12 rounds in the system!"

I watched as Danny moved the gun sight in the cabin door. The turret obediently followed the same path he mapped with the gun sight. I always got nervous during this step. Even though the gun was "dearmed," standing there while the business end of the minigun's six barrels passed by you as the turret rotated was unnerving.

The next step in the procedure was the low and high fire rate dry fire. Danny waited momentarily to pull the trigger because the flight line was busy. A-1s taxied by, loaded with bombs, napalm, and rockets. T-28s, AC-119s, C-130s, and even A-26s added to the din. Finally Danny got a clear zone in the action and pulled the trigger.

Simultaneously I glanced down at the gun. My heart jumped as I noticed the empty link hanging out of the feeder delinker unit. The gun was not cleared! There were still 12 rounds in the system! I raised my arms and tried to yell over the roar of the APU and taxiing aircraft as I began moving towards the cabin to warn him.

Suddenly events slowed down surrealistically. I actually saw the 12 rounds (2 tracers) pass under my upraised left arm. I followed the rounds out and through the center of a perfect triangle, formed by an end-of-runway (EOR) crew truck, a fuel truck filled with AVGAS (not wimpy J-P4), and a C-141 on final approach.

The roar of the gun rolled out over the flight line and disappeared into the surrounding jungle. You never forget the sound of a gatling gun when it fires. Even on "low" fire rate, a gatling gun doesn't report sharply. It moans eerily as 20 rounds a second leave the barrels. The 12 rounds we fired off took just over half a second.

We were lucky. Had I stepped off to warn Danny half a second sooner, I wouldn't be writing this article. The EOR crew and POL driver were not real understanding either.

I still cringe when I recall this incident. Where was the tech data? In the line shack. We had done this task so many times before we had it down cold. But the crew chief interrupted our normal routine, and we didn't recover. Who was in charge of the operation? No one.

The lesson? **Always follow your tech data.** It may save your life. Performing routine tasks can lull you into a false sense of mastery of what you are doing. But anything can interrupt a task and allow you to miss a step, with disastrous results. Military operations are particularly prone to external changes which can disrupt your routine or a deployment. Even moving from day to swing shift can introduce hundreds of distractions which can kill you. Discipline and tech data are your best defenses. ■

Operational Ris

JIM QUICK
MAJOR BILL WAGNER
HQ Air Force Safety Agency

■ We make a lot of assumptions and generalizations in the flying business which are seldom 100 percent accurate. But when they are mentioned in any crowd of two or more Nomex-clad warriors, they will get the heads nodding in the affirmative.

One such scenario comes to mind: "It is a given that when the weather gets bad, certain things inevitably happen. First, the weather won't REALLY get bad until you're thinking about landing and you're a little short on gas.

"Second, there will be controller training in the GCA shack.

"Third, the TACAN is NOTAM'd out, and the airfield folks have chosen this relatively slack time in the flying day (due to weather) to work on the ILS."

So you are given this information by approach control, and you must make an immediate decision in a compressed time frame. You've got to make a decision — NOW. The SOF has given you the standard, "standby" response. You can't remember how to work the diversion range chart. Another aircraft enters the pattern with a call sign which sounds like yours — at least to the controller. And gas is REALLY getting to be a problem. It's pretty obvious you've ended up in a primo risk management situation.

This scenario is factual, recent, and a good one to use in a discussion of operational risk management. A simple two-ship to the range eventually resulted in a one-ship recovery, with the wingie ejecting on short final at the alternate. No fireball — no gas. At the outset, though, this mission was nothing more than the "standard" range two-ship. Couldn't have been easier.

Both pilots were highly experienced fighter types — plenty of time in the cockpit, and they were current. The weather was a standard humid summer with afternoon thunderstorms. Nothing the crews or the squadron infrastructure couldn't handle.

The mission was adequately planned — all paperwork was done, good briefing, etc. The squadron SOF did his job and supervision was adequate. NOBODY attached ANY risk to this training mission.

How could this event have been managed better? The three pillars of risk management are:

- Do not accept unnecessary risk;
- Make risk decisions at the appropriate level; and
- Accept risk when benefits outweigh costs.

Accept No Unnecessary Risk

While this mission didn't outwardly indicate a high degree of risk, there were certainly a number of hazards which could have been controlled.

- Weather was bad — worse than forecast. The weather had been getting bad this way for days. This risk could have been managed easily: Fly another day, change takeoff times, alert the flight while they were on-range, etc.
- Airfield facilities were degraded. In fact, they were nonexistent. These hazards, in a risk management approach, could have been easily identified. The TACAN was NOTAM'd

sk Management

out. The ILS was inop, and the info was passed to the command post. It was not posted.

- Controller communication was difficult — two aircraft with similar call signs. One aircraft was responding to vectors intended for the other. Both became lost in the local traffic pattern. This was a pop-up risk which frequently happens in flight.

When you're out of gas, confused, lost, in the weather, with an alternate available only a short distance away, you'd better manage your destiny and be ready to do it.

Your assessment of risk in this situation should be immediate with risk controls and decision done promptly and correctly. A typical decision and control would have been to declare an emergency, squawk 7700, and climb direct to the alternate.

- The diversion range chart was confusing. If it's confusing during the annual instrument refresher class, it will be nothing but a hazard in the cockpit during the heat of action. Manage this problem with more training. Lean back in your king chair, open a cool one, and learn the sucker. Furthermore, learn it for ALL of your divert fields at the local 'drome, then apply it to your next exercise base. Get it out in the briefing, and refer to it under the contingency section of your recovery plan.

Make Risk Decision at the Appropriate Level

Operational risk management is a simple process. It consists of four steps.

- Identify the risk
- Assess it
- Decide on controls
- Implement

All that remains is to monitor the process, revising as necessary as the situation progresses.

Risk management is a group process which depends on the expertise of the "broom pusher" as well as the safety folks (experts in risk identification and assessment) and supervisors.

However, it is not an AD HOC process, but rather a quality endeavor, with the bottom line decision on risk acceptance being made by the responsible party.

In this case, the SOF, acting for the ops officer or commander, the flight lead, and finally the mishap pilot constitute the correct level in the descending risk decision/control process.

Accept Risk When Benefits Outweigh Costs

If a unit's airplanes are grounded, there is no opportunity to exercise or employ the capability those airplanes represent. However, operating at the opposite end of the "balance beam" of risk-versus-opportunity (i.e., taking all the opportunity available without the benefit of identifying and assessing risk) would also deplete the same capability through mishap-caused attrition. Exploring new avenues to "train like we fight" begs managing risk by taking a balanced approach to the employment of weaponry.

There will never be a risk-free mission. A simple process of identifying/assessing/controlling risk provides a system focusing on mission accomplishment, but minimizing hazards, while broadening combat capability. ■

Moments From Disaster

CAPTAIN R. E. JOSLIN, USMC

■ We normally do not associate "pulling Gs" with helicopters. Consequently, our lack of understanding of this phenomenon has been a factor in past mishaps. Undoubtedly, it will be so in the future unless we educate ourselves about exactly what is happening to a helicopter maneuvering at high angles of bank.

Two previous Navy/Marine mishaps, in particular, involved operating at high angles of bank, close to the ground, with the pilot at the controls flying cross-cockpit (flying from the left seat and turning right or vice versa), resulting in the aircraft descending and hitting the ground.

Let us look at the dynamics involved, starting from level flight (rotor thrust equals weight), and then rolling into an angle of bank while maintaining constant altitude and airspeed. (See figure 1.) We know from experience that to maintain this energy state requires an armful of collective. This is because of the increased thrust (manifested as collective position) required to provide an antiweight (vertical) component when the thrust vector is tilted from the vertical upon entering an angle of bank. That is, our apparent weight (G-loading) increases proportionally with the angle of bank when we add sufficient power to maintain flight in a bank without losing any altitude or airspeed. To determine G-loading, take the inverse of the cosine of the angle of bank.

Representative angles of bank and their associated G-load are tabulated in figure 2. Example: If we are in a 60-degree angle of bank, then we are pulling 2 Gs, which essentially means we weigh twice as much as our straight-and-level gross weight. That is if we increase our power sufficiently to maintain the same altitude and airspeed, but in a bank.

What happens if we don't have the power available to lift twice our gross weight or if we don't apply collective immediately upon rolling into a bank? Figure 1 shows we no longer have an equilibrium of vertical forces, hence we accelerate downwards in the direction of the unbalanced force.

For illustrative purposes, let us assume we are flying along at 300 feet above ground level (AGL) and roll into a 60-degree angle of bank while maintaining our airspeed, but with-

We normally do not associate "Pulling Gs" to helicopters. Consequently, our lack of understanding has been a factor in past mishaps. Flying Safety magazine first ran this article in October, 1988. Recent events warranted a reprint. Helicopter pilots — take heed!

out increasing our collective or power. How long will it take before we hit the ground? Figure 3 plots the time to impact from various entry altitudes AGL and angles of bank, assuming no initial vertical velocity.

Actually, the plotted time to impact corresponds to when the altitude sensing port hits the ground, which obviously will be preceded by main rotor blade impact. This plot is independent of the type of aircraft or gross weight and is merely a function of angle of bank. Note that a partial application of power or a reduction in airspeed will increase the time to impact. Conversely, power reductions or increases in airspeed will decrease the time to impact. Also, any initial rate of descent present upon entry will decrease the time to impact while the initial rate of climb will increase the time to impact.

Another factor, not considered, is the change in parasite power required due to a change in the area exposed to the freestream flow when we go from straight-and-level flight to an angle of bank. For our example, starting at 300 feet AGL and rolling into a 50-degree angle of bank without any power adjustment while maintaining our entry airspeed, the time to impact is approximately 6 seconds — which is probably how long it took you to read this sentence!

A moment's hesitation in applying collective or distraction — due to a radio communication, caution panel/warning light illumination, traffic calls, visual disorientation, or whatever — coupled with a failure to immediately satisfy the power requirement when rolling into an angle of bank at low altitude, will result in a downward acceleration that puts you just MOMENTS FROM DISASTER! ■

Figure 1

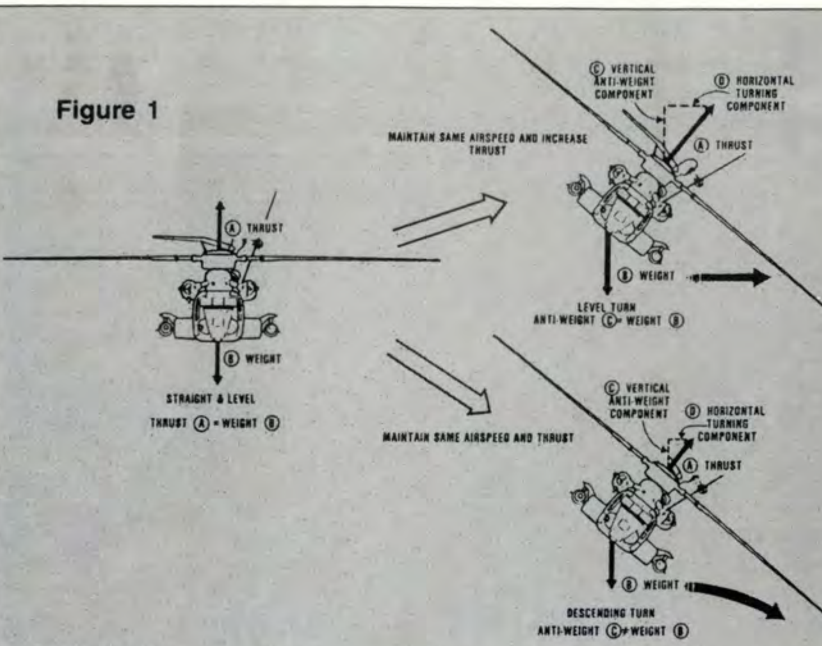
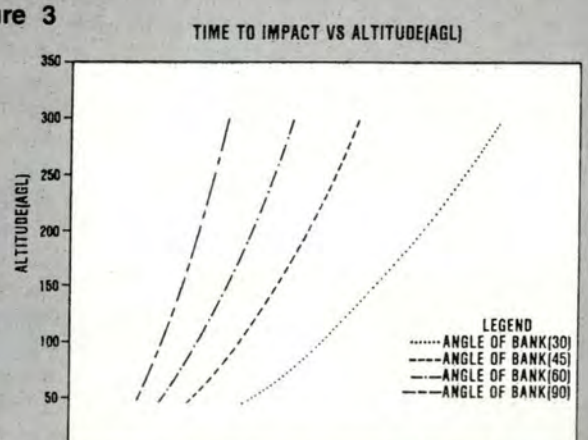


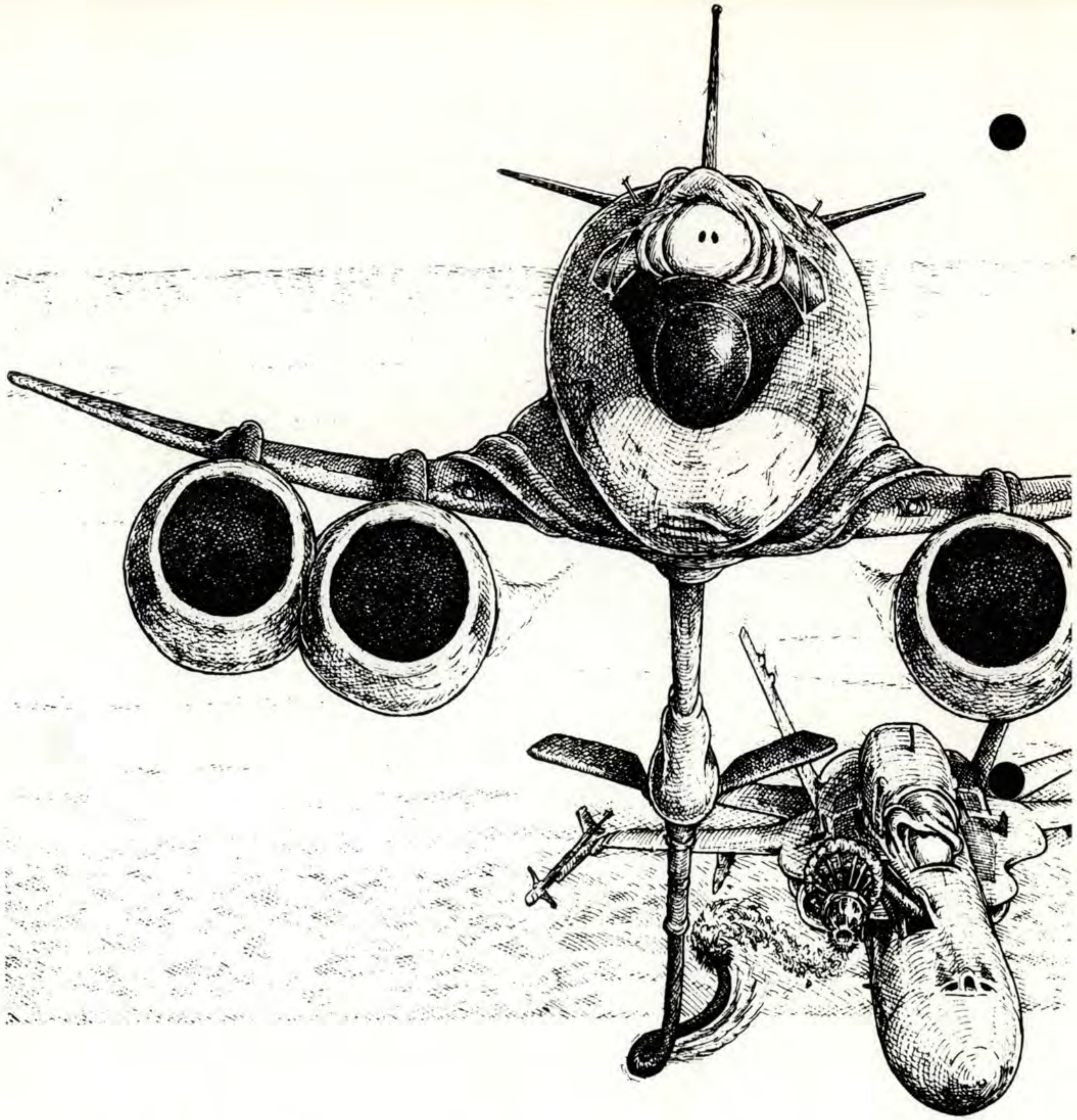
Figure 2

ANGLE OF BANK	★ G LOAD
0	1
10	1.02
30	1.15
45	1.41
60	2.00
75	3.86
85	11.50
89	58.82
90	∞

★ APPARENT WEIGHT WHILE MAINTAINING ALTITUDE AND AIRSPEED AT LISTED ANGLE OF BANK

Figure 3





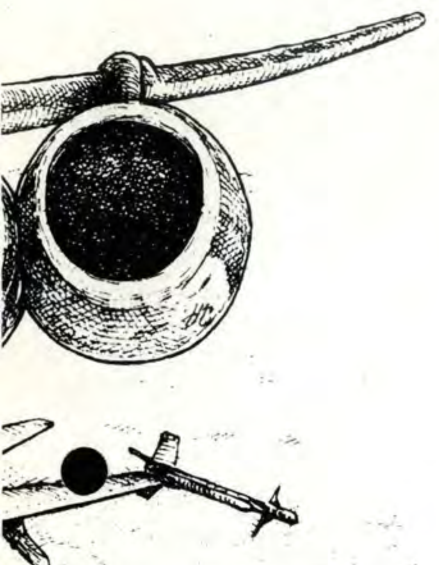
Seriously... It Just Blew!

LCDR GARRY MACE
Courtesy *Approach*, July 1994

■ During our deployment to the Arabian Gulf, I was the flight leader for a section of Hornets on a high-visibility Strike-ex in support of Operation Southern Watch. The mission itself went like clockwork. We collected lots of good FLIR target footage because, after all, if it's not on tape, you weren't there. After completing our primary mission, however, things became a bit more interesting.

Outbound from Iraq, we stopped

Naturally, my first thoughts were of self-preservation. Who would ever believe it wasn't my fault?



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to visit "Hoser 31" for a bit of fuel prior to returning to mother. Approaching the KC-135's basket, I smoothly (No kidding!) engaged my probe. With the reassuring "clunk" of a normal (I'm serious!) engagement came my big surprise: The KC-135 basket unceremoniously separated from the hose and remained firmly attached to my refueling probe!

With a horrified boom operator screaming for an emergency breakaway, and my giggling wingman scrambling for his camera, I asked our tanker comrades why I was wearing a perfectly good basket after such a silky smooth (I swear!) engagement.

The boom operator offered this explanation.

"Sir, you did nothing wrong." (His words, not mine!) "The aircraft that just left had quite a battle with the basket and damaged his probe. The basket didn't look badly damaged, but evidently it was. You made a normal engagement."

Naturally, my first thoughts were of self-preservation. Who would ever believe it wasn't my fault? My wingman was an LSO *and* former NAV-CAD; obviously, his word was worthless.

I remembered all the times I had scoffed at the claims of "1 to 2 knots closure" reported on previous aviation hazard reports about Hornet tanking incidents. Surely this was different — it just blew! In a flash of brilliance that still amazes me, I flipped on my VTR tape, told the boom operator his last transmission was broken, and asked him to "say again" his last.

With my alibi documented on Memorex, I began my RTB with my newly acquired souvenir. My aircraft was not damaged, so that was not my immediate concern. Unfortunately, I did not get a drop of fuel out of the tanker before taking possession of his basket, so fuel became my primary worry.

Complicating my bingo options were the extra drag of the attached basket, airspeed limits on an extended probe, and, most importantly, the possibility of serious aircraft damage or FOD if the basket separated from the refueling probe.

I told Strike about my low fuel and divert options through our E-2C. I estimated I had enough fuel to fly to the ship and, with a charlie on arrival, make one pass before I would have to bingo to our divert field. I was instructed to return to the ship to a ready deck.

Executing a modified bingo profile, I tried to find a happy medium between a fuel-efficient airspeed and an airspeed which was agreeable to my undulating trophy. This modified profile required constant calculations to track the progress of my dwindling fuel. Basic fuel flow and time-to-go showed it was gonna be close.

Another consideration was the power response and flight characteristics of my Hornet in the approach configuration with the probe extended and heavy basket forward of my CG. I dirtied up the descent and, after a quick controllability check, decided against using auto throttles. (Auto cripples can relate to the increased anxiety I now felt!)

Much to the delight of my squadron mates, the basket remained firmly in place during arrestment.

I should have known being safe on deck was just the beginning of my problems. As you might imagine, everyone in the air wing was very polite about the whole issue, and no one doubted my story … not!

By the time I debriefed the mission and got below decks to our ready room, my 60-pound prize was perched precariously over my chair. A steady stream of visitors came by to admire it. There it was, strung just inches above my head for a tremendous photo opportunity. The safety officer grimaced at the mishap just waiting to happen, but that's another story. ■

MAINTENANCE MATTERS

FOD Flounders Fighter

■ An F-16 pilot found out the hard way foreign objects damage aircraft systems other than the usual tires and engines.

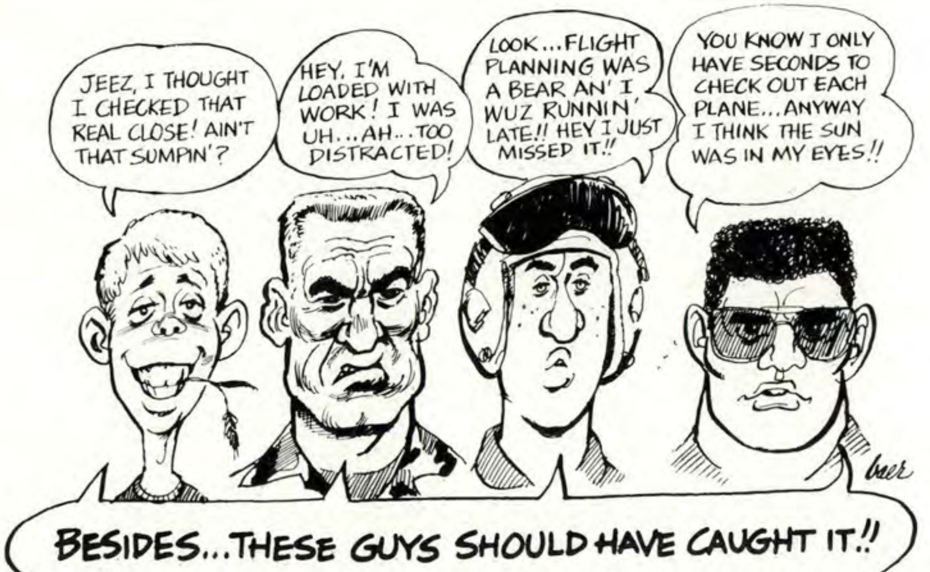
His jet landed normally with the gear down and locked for a straight-in, full-stop approach. On the landing rollout, with three green, light out in the gear handle, and good hydraulic pressure, the main gear suddenly retracted and the aircraft settled to the runway. There was extensive structural damage to the airframe and flight controls, but the pilot was uninjured.

There were no blown tires and the gear handle was in the *down* position. So what happened? It seems the gear control handle assembly had a small piece of safety wire/seal inside which stopped the gear handle mechanism from being fully down and locked.

We usually find this kind of painful "gotcha" as a result of a flight or ground mishap. So yes, it is possible (at least on F-16 aircraft) to have the gear handle DOWN, three GREEN lights, and the RED light out in the gear handle and still have an unsafe gear upon landing.

Action is being taken by depot to prevent a recurrence, but in the meantime, we must continue to do our part in FOD prevention.

Cockpit or flight line, FOD surveillance is a must!! ■



Another Nose Gear Scissors Story ... Again!

■ Well — once again — another pilot found out what happens to aero-machines that taxi or land with the nose landing gear scissors **not connected or improperly connected.** As in the other "scissors mishaps," pilot skill and an ounce of pure luck kept this mishap from being the stuff that makes front page news.

This mishap hurts even more when you know there were four — *repeat* — four people involved in **not** ensuring the scissors were connected properly.

Of course, the first person was the ground crewmember who was supposed to connect the scissors. The second was the individual responsible for the red X inspection. The pilot was the third and the end-of-runway (EOR) inspector was the last.

It's unimaginable four people performing **four separate inspections** would all fail to find the improperly connected nose scissors, i.e., the last-chance EOR inspector.

Could they all have experienced task saturation or the day-in-day-out-boring-routine syndrome or checklist complacency or a lack of proper training or maybe a combination of any of these?

Again — *repeat* — again we are reminded that anyone of the four mishap participants could have stopped the mishap development if just one of them would have performed their task responsibly.

Wonder what kind of "safety culture" this mishap unit has developed? ■

*U.S. GOVERNMENT PRINTING OFFICE 1994-573-261/03001

UNITED STATES AIR FORCE

Well Done Award

Presented for outstanding airmanship and professional performance during a hazardous situation and for a significant contribution to the United States Air Force Mishap Prevention Program.

CAPTAIN
Anthony J. Smith

CAPTAIN
Quinten L. Miklos

CAPTAIN
James D. Labombard

CAPTAIN
Kenneth G. Bock

Headquarters 28th Bomb Wing, Ellsworth Air Force Base, South Dakota

■ A conventional bombing mission suddenly turned into a life-threatening flight when a unique series of equipment failures, unimagined in any emergency procedures simulator, challenged this Ellsworth AFB B-1B crew. Captains Smith, Miklos, Labombard, and Bock entered IR-293 for a 550-knot, 500-foot AGL low level navigation leg prior to their scheduled entry to the Utah Test and Training Range. Capt Smith, the instructor pilot, was monitoring Capt Miklos, the copilot, who was executing terrain masking procedures. At a turn point, rolling through 30 degrees of bank and belly up to a ridge, the aircrew heard a loud bang accompanied by a violent shudder. This was immediately followed by the illumination of the master caution, multiple caution lights, and the forward weapons bay door lights.

Capt Miklos maneuvered the aircraft clear of the terrain and initiated a climb to exit the route. The crew correctly identified the never-seen-before emergency separation and loss of the 20,000-pound internal forward stores bay fuel tank. They then expertly coordinated an F-16 chase to check the aircraft as they diverted into Hill AFB, Utah, for an emergency landing.

During the cruise to Hill AFB, the aircraft began to vibrate, and the Nos. 3 and 4 engines showed signs of compressor stall. Additionally, the chase aircraft reported blue smoke from the engines and vapors coming out of the right engine nacelle. Based on this information, Capt Smith shut down the stalled engines. At this point, in addition to the loss of two engines, the aircraft was flying without one generator, two hydraulic systems, and numerous subsystems. The crew cleaned up a myriad of emergency checklists and set up for a visual approach.

On short final, strong fuel fumes entered the cockpit causing the crew's eyes to water severely. The instructor pilot was unable to see, but through concise coordination with his crew, he was able to smoothly transfer aircraft control to the copilot at approximately 100 feet AGL. The copilot safely landed and stopped the aircraft, becoming the second pilot to ever have landed a B-1B with two engines out.

Post-flight inspection revealed additional damage from the departed fuel tank debris to the Nos. 1 and 2 engines, further supporting this crew's quick response in diverting to the nearest suitable airfield. The aircrew's prompt action solved this new type of emergency and saved a valuable aircraft.

WELL DONE! ■

ANNOUNCING

THE AIRCREW SAVER AWARD

Everybody knows there are jobs in today's Air Force that have to be done right the first time. In many cases, they involve work on systems we hope we'll never have to use. However, there's one special group of people whose diligence sometimes sees a pretty spectacular payoff. They are the women and men responsible for ejection seats, parachutes, and survival gear. You can't "test fire" an ejection seat; you can't "test open" parachutes. All you can do is make them as ready as humanly possible against the time when they suddenly become *the* last chance for aircrew members.

While fighter pilots have a tradition of presenting parachute packers with a case of their "beverage of choice" following a successful ejection, other people should get to take a bow, too. Modern ejection systems require several systems, all working together perfectly, to successfully take someone from an aircraft in trouble and deposit them safely on the ground. There are also a lot of aircraft in our inventory where the good old strap-on parachute is the only way out, and that needs to work right the first time, too!

The Chief of Staff, General Merrill A. McPeak, recently decided the Air Force needed a special award recognizing the people who give our fliers that second chance. The new award will be called the USAF "Aircrew Saver" Award. It'll be requested by wing commanders and authorized by the Chief of Safety for each person responsible for the final installation, certification, or inspection of each major component of systems used for successful escape from a disabled aircraft. Each award will be unique in that it will name not only the recipient, but the person or persons whose lives have been saved by the recipient's professionalism.

The award will also be authorized to recognize people who contribute to the successful recovery of aircrew members from a life-threatening situation following an ejection or bailout. The purpose is the same — to recognize people trained to work on search parties, as rescue helicopter crewmembers, as firefighters, or in other specialties where lives depend on supremely professional knowledge and execution of specific duties in an atmosphere of crisis.

Award applications will be accepted beginning 1 October 1994.

For more information, contact your local wing safety office.